


GENE ARMAGEDDON THE PEST CRISIS



Gene Armageddon

The Pest Crisis

With the influence of abnormal global climate change and the growth of the population, the crisis of food poverty cannot be overemphasized. Pest has long been the nemesis of scientists since the existence of agricultural civilization. A life-or-death battle of competing for food resources has begun. Whether you are the pests that evolve through the selection or the scientists that integrate synthetic biology into insecticidal toxins, squeeze your brain for the victory!



In the game, when you are a scientist, players can learn some basic principles of synthetic biology.

The Central Dogma of Biology is a flow of genetic information. DNA turns into messenger RNA, and mRNA turns into protein. The initiation of transcription requires four parts.



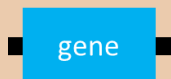
PROMOTER

Promoter is a short DNA sequence RNA polymerase bind to during transcription.



RIBOSOME BINDING SITE/RBS

RBS is a sequence ribosome bind to in messenger RNA during translation.



GENE

Insert Gene is a DNA sequence that encodes the formation of protein.



TERMINATOR/TER

Terminator is a short DNA sequence that stops RNA polymerase during transcription.

With the composition of the four parts, we may engineer bacteria e.g. *E. coli*, and let the bacteria express the protein we want.

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Card Description

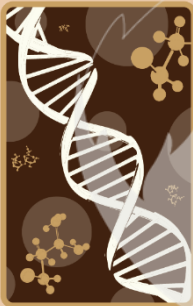
Game Formation



Role Card

16 pieces are included.

Pests and Scientists are the two battling groups. There are eight pieces in each group.



Resource Card

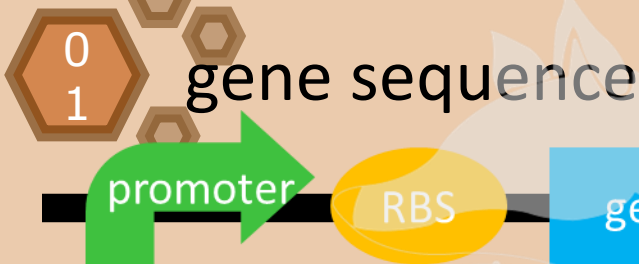
124 pieces are included. There are 20 Surrounding Card and 104 Phenotype Card. Resources consist of Phenotype Card and Surrounding Card. They have the same DNA pattern in the back of the card, and players have to spend resource to initiate effects or develop phenotypes.

I	I
1	1
2	2
2	2
£	£
3	3

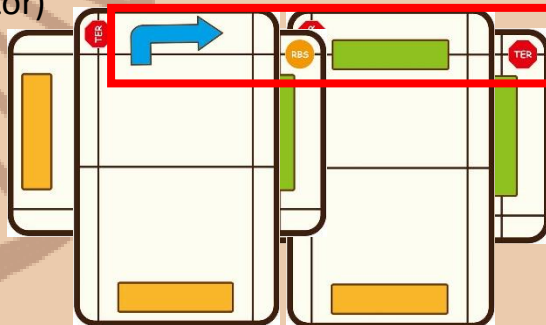
Additional Object

The additional object contains six pieces of small card. Players may separate them and fold them into 3D objects. An additional object is needed when the phenotype "**mimicry**" is initiated. It is used to mark the identical phenotype.

Description of Specific Term



Scientists must work together to finish a complete gene sequence. Only when a gene sequence is complete with the correct order of a promoter, an RBS, an Insert Gene and a Terminator will the function of the gene be initiated. Scientists do not need to complete the gene order in the revolving order of players, but the gene sequence should place in the correct order. Besides, a gene sequence is allowed to contain multiple insert gene with the addition of an RBS respectively. (Example Order: Promoter + RBS +Insert Gene + RBS + Insert Gene + Terminator)



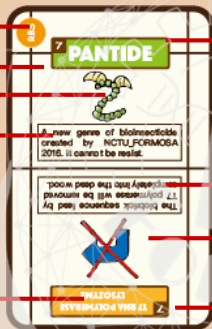
Description of Specific Term

0
2

Developing Phenotype

The Pests develop its individual phenotype respectively, and each phenotype requires resource units marked on the upper left corner of the card name. Phenotypes should be placed under the role card.

RBS or Terminator
The number of
resource unit
Card Portray
Card Description



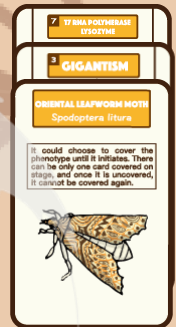
Promoter or Gene

Card Description

Card Portray

Phenotype

The number of
resource unit



Resource

0
3

Resource Cards contains Surrounding Cards and Phenotype/Gene Card. They have the same DNA pattern in the back of the card and can be all used as one resource unit. Specifically, a single Surrounding Card can be used as two units of resource whereas other Phenotype/Gene Card can be used as one resource unit. Phenotype/Gene Card is a card that is split into two parts. The function differs according to the group players belong to. Scientists use gene while Pests use phenotype. Phenotype/Gene Cards have the labeling of how many resource units a phenotype or gene requires and Card description. On the right-up side of the card are RBS or TER. RBS and Terminator can be used by scientists without resource unit and also can be used as "Trigger Test."



Description of Specific Term



04

Trigger Test

Some specific cards require a trigger test. Trigger test is a test that decides whether a card can initiate or not. The trigger test is done by drawing an upper card from the deck. If the card is an RBS, the test is successful. If the card is a Ter, the test is failed. The card players draw as trigger test should be placed in the bottom of the deck.



05

Lethal Toxins

Lethal toxins are genes that are used by scientists. Scientists must initiate lethal toxic gene to kill off the pest for victory.



06

Lethal Toxin Resistant Phenotype

The pests develop lethal toxin resistant phenotypes to resist lethal toxins for victory.



07

Death Condition

When the pest encounters two kinds of toxins, it cannot resist until the end of the round. Some cards are initiated after death.(e.g. Parasitism)

Frankenstein dies when there is no card in hand in the round.

Setting Action before the Game

0
1

Players distribution

Total players	Scientists	Pests
4 players	2	2
5 players	3	2
6 players	3	3
7 players	4	3
8 players	4	4

0
1

Distribution of hand cards

At the beginning of the game, players draw out the role card randomly according to the role distribution and shuffle the role cards. After shuffling, players draw out their own role card randomly. Each player has only one role. In the first round, every player has five cards in hand, but some of the roles would have more than five cards according to their special power.

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3

Arrangement of seats

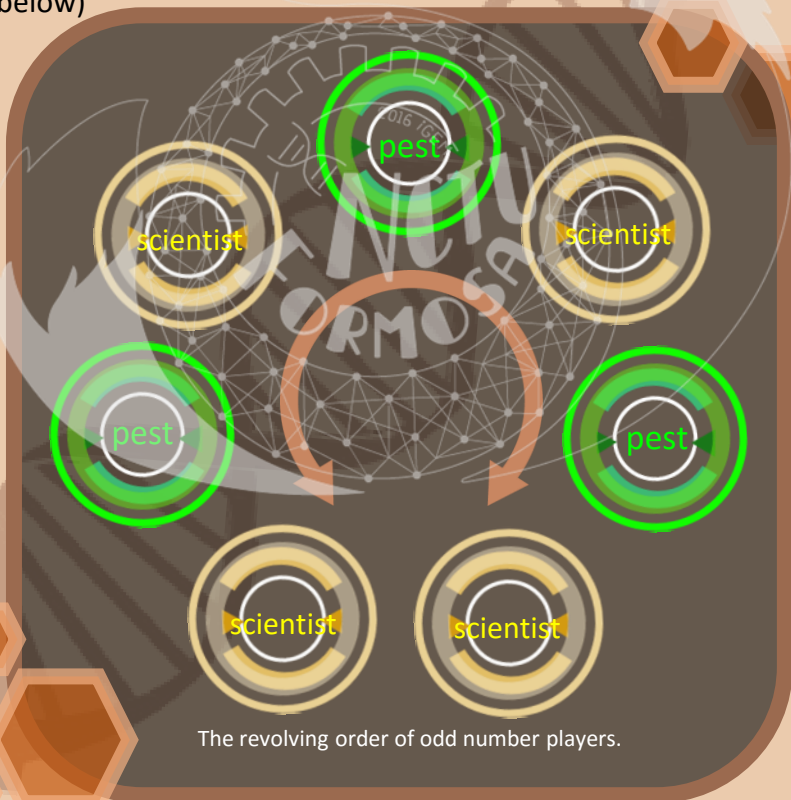
Scientists and pests have to arrange in the crisscrossed order below.

The revolving playing order is determined by the total number of players as below.

Revolving Order

Even-number players: counterclockwise order.

Odd-number players: The game starts with a scientist and turns to the next player who sits beside the scientist. Until the game turns to the last scientist of the round, the order reverses the order and new round starts. (The order is shown below)



Start the Game

Draw cards

Every player draws two cards at the start of his or her own round, and any effect that influences the number of drawing card will initiate at the same time.

Use the Surrounding Card

In this stage, the player can choose whether to use the surrounding cards that make the assorted group discard or draw cards.

Build up biobrick Develop phenotype

Players build up biobricks or develop phenotypes according to the group they belong to and spend the resource cards in hand. If there is any card that affects the construction of biobrick or development of phenotype, it will initiate at the same time. A single player can only achieve one action in a single round. That is, the scientist can construct one part or the pest can develop one phenotype.

In this stage, the player can choose whether to use the surrounding card that makes the assorted group discard or draws hand cards.

Use the Surrounding Card

End of the round

Determination of death of the pest



Claim for Victory

The Scientist

The Scientist claims for the victory once the pests on stage are all killed.

The Pest

The Pest has two ways for victory:

- 1) Once there is at least one pest that develops four kinds of toxin-resistant phenotype, The Pest wins.
- 2) Once the resource card deck exhausts, The Pest claims for the victory. Note that the cards in the deadwood would be shuffled to become the deck again and times of shuffling the card are limited according to the number of players.

4~5 people: When the resource deck has exhausted for two times.

6~8 people: When the resource deck has exhausted for three times.

****The effect of role card initiates in different timing respectively, we will elaborate on it in the description of the role card later.**

Card Description

Role Card

The Scientist

1. Alien

The alien civilization has the technique to modify the pest. Whenever the round to itself, it can remove a phenotype from a pest at will. However, the removal of the card requires the same cost of the phenotype's resource units. For example, Alien spend four resource unit to remove Exoskeleton Strengthening. The removed phenotype goes into Deadwood. In each round, Alien can use the technique for only one time. After using the technique, Alien can still construct biobrick and initiate Surrounding Card.



2. Frankenstein

Science Maniac is a mad scientist that never plays by rules in the experiment. When the game turns to his own round, he can choose to retrieve a promoter or a gene on stage that helps the Scientist alter the part or continue constructing other genes.



Card Description

The Scientist



3. Science Maniac

Science Maniac is a mad scientist that never plays by rules in the experiment. When the game turns to his own round, he can choose to retrieve a promoter or a gene on stage that helps the Scientist alter the part or continue constructing other genes.



4. Science Brainiac

Science Brainiac is endowed with unusual intelligence, who has a tremendous contribution to The Scientist. In the first round, Science Brainiac has seven cards in hand.



5. President of Academia Sinica

The president of Academia Sinica holds the cutting-edge technology. Whenever his own round ends, he could exchange a card in hand with the first card on the deck, so that he can control the card drawn by the following player.

Card Description

The Scientist

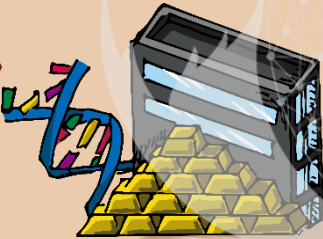


6. Entomologist

Entomologist focuses on insect research. Whenever his round ends, it can choose to exchange a hand card with a pest.

7. Biotechnology Corporation

Biotechnology Corporation has powerful financial strength. Whenever it is in its own round, it can draw three cards in total. Biotech Corporation can provide other scientists on stage its resource unit, but the resource unit cannot be used as a functional card. For example, it can help pay the resource unit spent in constructing biobricks, or help pay the card discarded in the influence of surrounding cards)



8. *Escherichia coli* BL21

E. coli BL21 is a bacteria strain that is suitable for expressing the protein. Therefore, when it constructs biobrick, it can spend one less resource unit than the original requirement. For example, it can construct a constitutive promoter, which cost four resource units with only three resource unit.



Card Description

The Pest



1. Exotic Species

Invading from the exotic region, Exotic Species is brutal and has a strong adaptability. When the game starts, Exotic Species has seven cards in hand.



2. Oriental Fruit Fly (*Bactrocera dorsalis*)

Laying eggs in the fruit, Oriental Fruit Fly causes serious agricultural loss. When it dies, it can remove a complete sequence of biobrick into Deadwood. (A complete sequence of biobrick contains a promoter, RBS, Gene and a terminator)



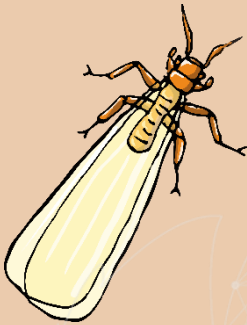
3. Citrus Long-horned Beetle

(*Anoplophora chinensis*)

Citrus Long-horned Beetle has an adamant exoskeleton. When the game starts, it has the phenotype exoskeleton strengthening shown in a small token on the role card. In its first round, it cannot draw a card from the deck.

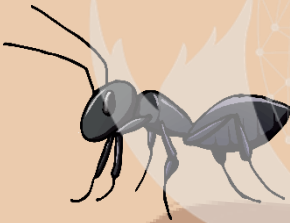
Card Description

The Pest



4. Termite

Termites can get energy from degrading fibers. Whenever it develops its phenotype, it could pay one less resource unit than the original requirement.



5. Ant

Ants are a social insect; they build up the empire through cooperation. In every round, it draws one more card. (that is, three cards totally) Ant can provide other scientists on stage its resource unit, but the resource unit cannot be used as a functional card. For example, it can help pay the resource unit spent in developing phenotype, or help pay the card discarded in the influence of surrounding cards.



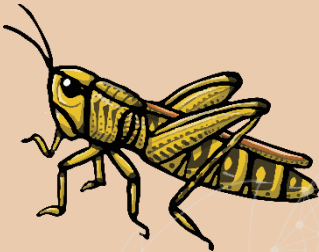
6. American Cockroach

(Periplaneta americana)

American Cockroach is a commonly seen domestic pest. Under no circumstances should American Cockroach discard hand cards.

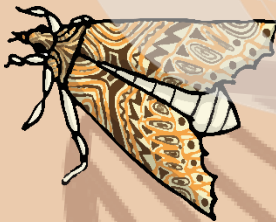
Card Description

The Pest



7. Locust (*Acridoidea*)

Locust has strong hind legs and incredibly huge appetite (Gluttony). When the game starts, Locust is immune to the surrounding cards on stage (Locust itself included) and it draws one more card every round. (That is three cards in total.)



8. Oriental Leafworm Moth

(*Spodoptera litura*)

Oriental Leafworm Moth has distinctive giant wings. When it develops phenotype, it could choose to cover the phenotype until it initiates. There can be only one card covered on stage, and once it is uncovered, it cannot be covered again.

Card Description

Surrounding Cards



1. Natural Enemies

Predation of pests. Each pest should discard two resource units when this card is initiated.



2. Blizzard

Extreme cold lowers the vitality of pests. Each pest should discard one resource unit when this card is initiated.



3. Policy: Eradication of Natural Enemies

A lot of natural enemies is eliminated, thus causing the prosperity of pests. Each pest can draw one card when this card is initiated.

Card Description

Surrounding Cards



4. Breeding Season

Insects prosper, consuming more resources. Each pest can draw one card when this card is initiated.



5. Great Depression

Economic depression. Each scientist should discard two resource unit when this card is initiated.



6. Experiment failure

Pest problems rage on as experiment fail. Each scientist should discard one resource unit while each pest can draw one resource unit when this card is initiated.

Card Description

Surrounding Cards

7. Policy: Eradication of Pests

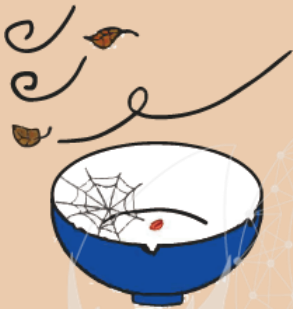
The government supports research concerning pest elimination. Each scientist draws one card when this card is initiated.

8. Technological Innovation

A technological breakthrough. Each scientist can draw one card while each pest should discard one resource unit when this card is initiated.

Card Description

Surrounding Cards



9. Decreased Food Production

An unknown reason causes crop production to decrease. Each player (both pests and scientists included) should discard one resource units when this card is initiated.



10. Rich Harvest

Crop production increases as no natural disaster occurs. Each player(both pests and scientists included) can draw two cards when this card is activated.

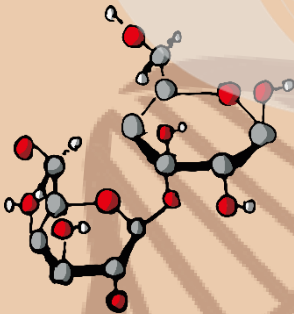
Card Description

Gene Card--Promoters Promoter

**The following word "RU" stands for "resource unit."



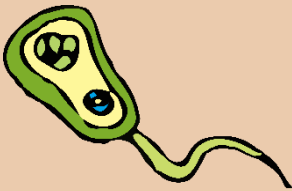
1. Light promoter (One RU required) The promoter will be induced through lights. It functions as a constitutive promoter on stage. However, once there is a pest that develops the phenotype "Nocturnality," the pest will be resistance to the following biobrick sequence lead by the promoter.



2. Lactose promoter (One RU required) The promoter will be induced by lactose. It functions as a constitutive promoter on stage. However, once there is a pest that develops the phenotype "Lactase," the pest will be resistant to the following biobrick sequence lead by the promoter.

Card Description

Promoter



3. AHL promoter (One RU required)

The promoter will be induced by a “quorum sensing” substance, AHL. It functions as a constitutive gene in a dense bacteria population. However, once the pest develops the phenotype “Symbiotic Bacteria Reduction,” the pest will be resistant to the following biobrick sequence lead by the promoter.



4. Electric promoter (One RU required)

The promoter will be induced by electric current. When the biobrick sequence lead by this promoter is complete, the last scientist who completes the sequence should spend one resource unit to act as an electric current every round. When the scientist cannot afford it, the whole biobrick will be turned down permanently.



5. GlnRS Promoter (Four RUs required)

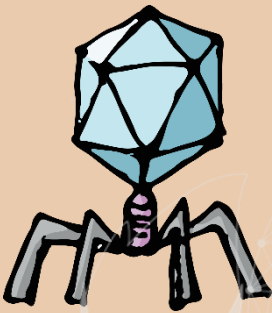
The promoter can enhance the expression of genes. The genes lead by the promoter can have one less RU to spend. For example, *Bacillus thuringiensis* crystal protein requires four RUs. When it is inserted after this promoter, it spends three RUs.)

Card Description

Promoter

6. T7 Promoter (Two RUs required)

T7 promoter comes from a bacteriophage. It is strong and suitable for expressing proteins but requires IPTG induction. Before initiating the promoter, the scientist should spend an RU for Trigger Test. If it is an RBS, the scientist can get three more resource card. If it is a TER, the scientist cannot draw any card. T7 Promoter will be destroyed by the phenotype "T7 Polymerase Lysozyme," and the following biobrick sequence will be destroyed, too.



7. Constitutive Promoter

(Three RUs required)

A normal constitutive promoter that cannot be resistant to the pest.



Card Description

Gene Card

Lethal Toxic Genes

1. Crystal Proteins of *Bacillus thuringiensis* (Four RUs required)



Through insect's highly-alkaline digestive juice, the parasporal Crystal proteins turn into perforins that destroy insect peritrophic membrane, which causes the death of the Pest. The Pest will have the ability to resist it after evolving the phenotype "Low Alkalinity Digestive Juice."

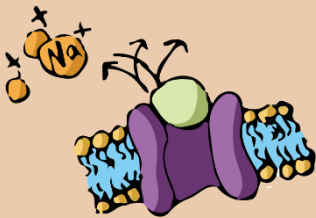
2. Acicular Crystallization (Four RUs required)



The acicular crystallization produced by plants such as taro punctures the mouthparts of the Pest and affects the food intake by the Pest, causing the Pest to die of inappetence. The Pest will have the ability to resist it after evolving the phenotype "Rocklike Mouthparts."

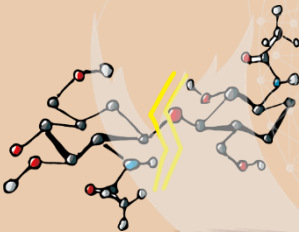
Card Description

Lethal Toxic Genes



3. Neurotoxic Protein (Four RUs required)

Neurotoxic protein binds to the ion channels in pest's nervous system, causing the death of the Pest. The Pest will have the ability to resist it after evolving the phenotype "Mutations of Ion Channels."



4. Chitinase (Four RUs required)

Chitinase degrades the external skeleton of pest, causing the death of the Pest. The Pest will have the ability to resist it after evolving the phenotype "Strengthened External Skeleton."



5. PANTIDE (Seven RUs required)

A new genre of bioinsecticide created by NCTU_FORMOSA 2016. It cannot be resist by the Pest.



Card Description

Gene Card Genes

Functional Genes

1. *pncB* (Two RUs required)

When *pncB* initiates, it can turn electric promoter into a constitutive promoter. For example: When there is an electric promoter and also an initiated *pncB* on stage, the electric promoter turn into a constitutive promoter that does not need electric current)



2. Green Fluorescence Protein

(Two RUs required)

When expressed, Green Fluorescence nullifies the phenotype “camouflage.” When the gene is successfully initiated, scientists may initiate the effect above for two times.



Card Description

Functional Genes



3. FNR + BisdA + BisdB

(Three RUs required)

The coupled enzyme facilitates the generation of energy. When expressed, it enables all the Scientist to draw two more cards (that is four cards in total) in every round.



4. CelD (Three RUs required)

When expressed, all the Scientist may have one resource unit discount in every biobrick construction.



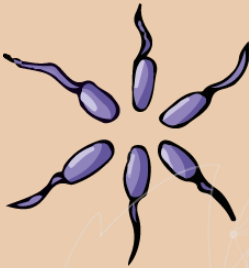
5. Phytohormones (Three RUs required)

Phytohormones dictate the growth of plants, thus reducing the influence of the surroundings. When expressed, all the Scientist are immune to the surrounding cards that have negative effect. (No need to discard cards)



Card Description

Functional Genes



6. AspA (Four RUs required)

When expressed, AspA enables all the Scientists to construct one more biobrick part in every round. (For example, a scientist may build up a promoter and an RBS subsequently.)

Card Description

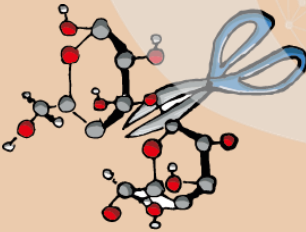
Phenotype Card

Promoter-resistant Phenotype



1. Nocturne (OneRU required)

The pest evolving Nocturne is resistant to the genes lead by the light-induced promoter.



2. Lactase (One RU required)

The pest evolving Lactase is resistant to the genes lead by the lactose-induced promoter.



3. Decreased Symbiotic Bacteria

(One RU required)

The pest evolving Decreased Symbiotic Bacteria is resistant to the genes lead by AHL-induced promoter.

Card Description

Phenotype Card

Toxin-resistant Phenotype



1. Low Alkaline Digestive Juice

(Four RUs required)

Toxin-resistant phenotype. The pest evolving the phenotype is resistant to Crystal Proteins of *Bacillus thuringiensis*.



2. Rocklike Mouthpart

(Four RUs required)

Toxin-resistant phenotype. The pest evolving the phenotype is resistant to Acicular Crystallization.

Card Description

Toxin-resistant Phenotype



3. Mutations of Ion Channels

(Four RUs required)

Toxin-resistant phenotype. The pest evolving the phenotype is resistant to Neurotoxic Protein.



4. Strengthened (Four RUs required)

Toxin-resistant phenotype. The pest evolving the phenotype is resistant to Chitinase.

Card Description

Phenotype Card

Functional Phenotype

1. Strong Hind Legs (One RU required)

The pest with strong hind legs can escape harsh environment. So it is immune to any surrounding cards, no matter the effect of surrounding cards is negative or positive.



2. Adipose Tissue (One RU required)

In every round, the player with Adipose Tissue can put one hand card under this phenotype that restores as one resource unit and the restored adipose tissue is immune to surrounding cards. However, the restored cards can be only regarded as RU. The player may use it whenever needed. When the phenotype is removed, the restored cards will be removed altogether.



Card Description

Functional Phenotype

3. Communication (One RU required)

The pest evolving Communication can provide other pests with its resource unit anytime in the game. For example, the pest may help pay the RU required for other pest's development of phenotypes.



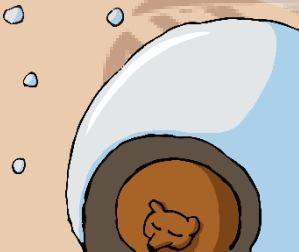
4. Parasitism (One RU required)

The pest evolving Parasitism can remove the first card in the card pile after being eliminated.



5. Hibernation (Two RUs required)

When the pest hibernates, it will not be affected by any cards and toxicity effect for the next round. The phenotype can only be initiated before the player draws cards. (Hibernation can be initiated for only one time. Rotate the card for 90 degrees when initiated)



Card Description

Functional Phenotype



6. Feign Death (Two RUs required)

When the pest faces the threat, it can initiate Feign Death that makes the pest escapes the slaughter from the Scientist for the next round; it can do nothing but draw cards. (Rotate the card for 90 degrees after Feign Death is over.)



7. Camouflage (Two RUs required)

The pest evolving camouflage survives one more round when facing irresistible toxins until the end of the next round. It will be nullified by Green Fluorescent Protein. (Rotate the card for 90 degrees after Camouflage is over.)



8. Gigantism (Three RUs required)

The pest becomes larger and larger to enhance the ability to fight against toxins. When encountered the irresistible toxins, the pest may survive for one more round. (Rotate the card for 90 degrees after Gigantism is over.)

Card Description

Functional Phenotype

9. Insanity (Three RUs required)

The Pest spread the disease that turns the Scientist into insanity. In next round, each scientist draws one less card. (Rotate the card for 90 degrees after Insanity is over.)



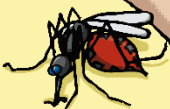
10. Poisoning (Three RUs required)

The poisoned humans require medical treatment. When Poisoning is initiated, all the scientists should discard one RU. If the player has no hand card, he or she does not need to discard one card. (Rotate the card for 90 degrees after Poisoning is over.)



11. Hemophagia (Two RUs required)

The pest feeds on human blood. The pest initiating Hemophagia may draw a card from any scientist.



Card Description

Functional Phenotype



12. Molt (Two RUs required)

Cuticle and toxins molt as insects grow. The pest initiating Molt discards one of its phenotype and may remove one of the biobrick part on stage.



13. Mutation (One RU required)

Gene mutates. The pest initiating Mutation may choose a scientist and exchange the same number of hand cards. (The two involved players may choose the card they want to exchange respectively.)



14. Gluttony (Four RUs required)

Enhanced appetite. The pest initiating Gluttony may draw one more card in each round, namely drawing three cards in total. (The pest is allowed to have more than one phenotype Gluttony and the effect are additional)

Card Description

Functional Phenotype



15. Maturity (Three RUs required)

Appetite enhances as insects grow. The pest initiating Maturity may draw one more card in each round, namely drawing three cards in total. (The effect of Maturity is not additional.)



16. Holometabolism (Four RUs required)

Insect's complete metamorphism. The pest initiating Holometabolism may exchange this card with any phenotype in the deck in the next round. After the exchange, Holometabolism is placed into the deck, and the deck should be shuffled.

Card Description

Functional Phenotype

17. Mimicry (Four RUs required)



Insect emulates desirable phenotypes on stage, duplicating any phenotypes from any other living pest on stage. The two players should place an “additional object” on the mimicked phenotype. When the mimicked phenotype is removed, Mimicry also nullifies simultaneously. For example, A pest initiates Mimicry, duplicating Low Alkaline Digestive Juice. At the moment the two card should be placed with an additional object for recognition. However, when the mimicked Low Alkaline Digestive Juice is removed, Mimicry nullifies. Mimicry card need not be placed into the deadwood nor initiated for the second time.



18. T7 RNA Polymerase Lysozyme (Seven RUs required)

The biobrick sequence lead by T7 polymerase will be removed completely into the dead wood.



Producers

2016 iGEM NCTU_Formosa Board Game

陸彤
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黃馨儀
陳玟嘉
陳楷文
陳麒升
李照宇

